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Joint Research Centre

SCIENCE FOR POLICY BRIEF

Mapping the transition of the EU ceramic industry to carbon neutrality

2026

HIGHLIGHTS

- The ceramic industry is progressing on its path towards decarbonisation with 39 demonstration projects identified, though further evidence is scarce (i.e. few pledges by industry; no overview of ongoing research).
- The industry is complex in its product offer and production processes, which is a challenge to decarbonisation. However, the relatively small size of production facilities provides an opportunity for decentralised (low-carbon) energy sourcing.
- The bottleneck for the transition lies in the supply of affordable decarbonised energy (biogas, hydrogen or electricity) rather than in technology readiness.
- The full decarbonisation of the industry will require carbon capture to address remaining process emissions from 2040 onwards.
- The main decarbonisation trajectories for the EU ceramic industry project emission reductions of 91-100% by 2050.

THE CHALLENGE

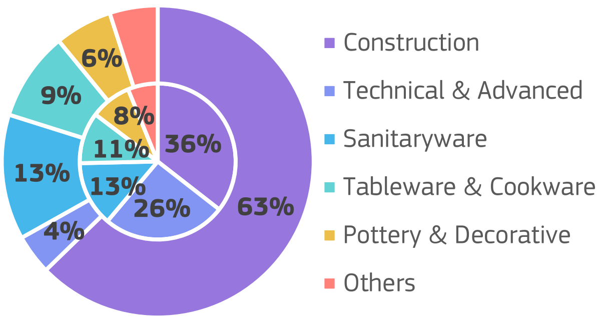
Introduction

Ceramics are goods stemming from shaping and firing non-metallic inorganic materials into solids. While the first ceramics date back to 10 000 BC, millennia of evolution have transformed this ancient craft into a technical industry, delivering products for a wide range of applications (Figure 1).

The European ceramic industry is diverse; its industry association (Cerame-Unie) recognises nine specific sectors [1] Three of them (wall and floor tiles; brick and roof tiles and vitrified clay pipes) represent the bulk of EU ceramic production and underpin the construction industry, together with sanitary wares.

Within the European Union (EU), the ceramic industry had a total turnover of EUR 26 billion and produced 8.3 million tonnes (Mt) of goods in 2023 [2]. Figure 1 breaks the industry down by product type, in terms of production volume (outer circle) and turnover (inner circle).

Figure 1 – 2023 EU ceramic market by product type



Source: JRC based on [2].
Notes: % EUR, inner circle; % tonnes, outer circle

The ceramic industry contributes to a positive EU trade balance of EUR 5.1 billion [1], exporting more than a third of production outside the EU. It counts close to 20 000 companies and is linked to around

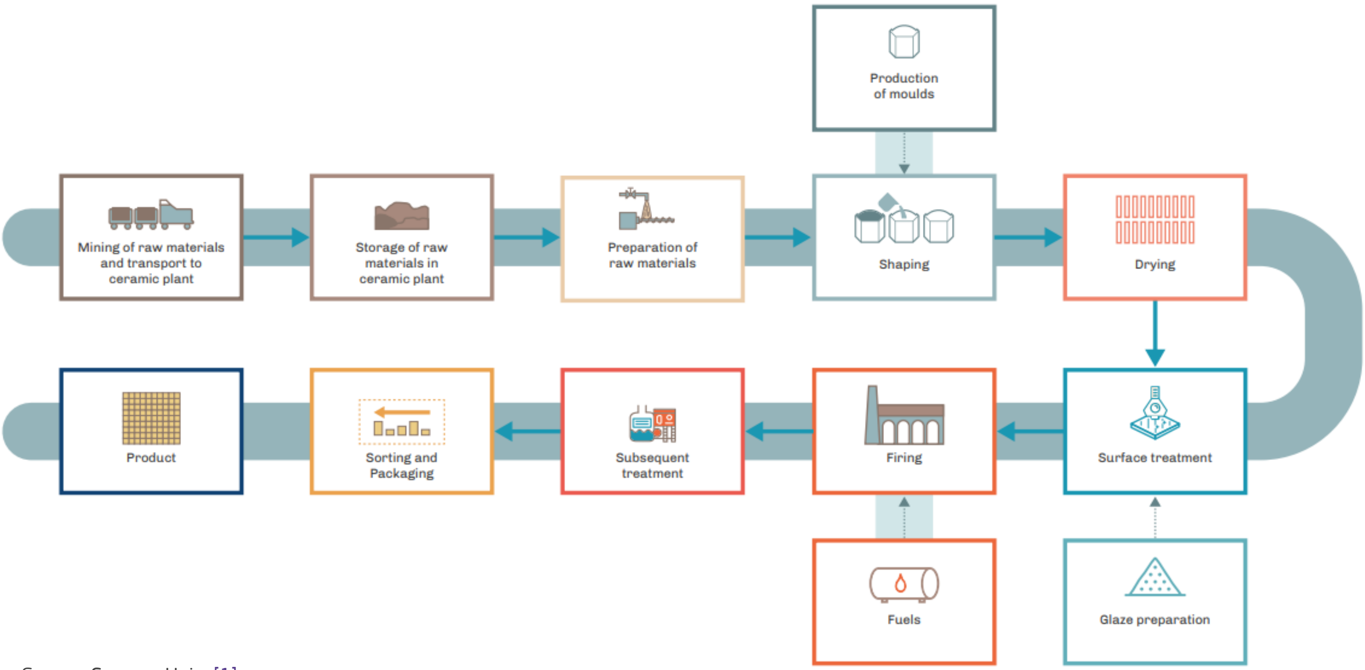
200 000 direct jobs [3], with significant variations across its sectors.

Although EU ceramic production decreased notably after the 2008 financial crisis, it has stabilised in recent years [4]. The projected production volumes of ceramics may increase by up to 63% in 2032 as compared to 2023 values [2]. In 2019, EU ceramic production led to around 19 Mt of CO_2 emissions [1], about 1% of the EU's greenhouse gas (GHG) emissions.

Production process

The ceramic production process starts with the sourcing, transport and preparation of raw materials (i.e. inorganic materials made of non-metallic compounds). Materials are then mixed and shaped. A drying step ensures an appropriate humidity level ahead of the firing, which sets the desired products through high temperature (from 450 °C for white fired technical ceramics to over 1 800 °C in the case of refractory manufacture). Finishing treatments may be applied for functional and/or aesthetic reasons. Depending on the sector and product, different combinations of the above steps may be used (see Figure 2) and several technologies are available for each of these various steps (Table 1) [5]

Figure 2 – Simplified diagram of the manufacturing of ceramic products



Source: Cerame-Unie, [1].

Table 1 – Non exhaustive overview of technologies for key steps

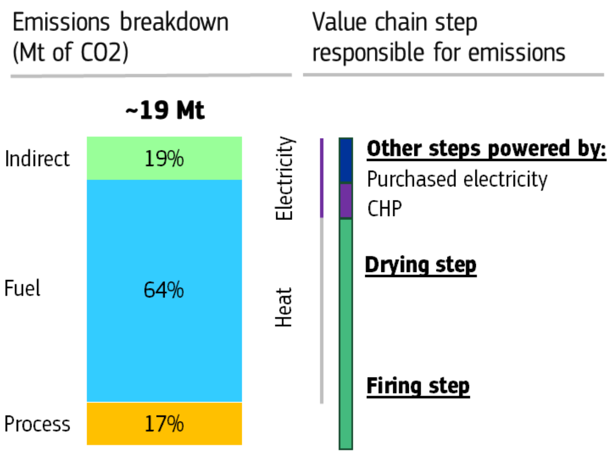
Shaping of ware	Drying	Firing	Further treatments
Mechanical / hydraulic pressing	Hot floor dryers	Periodic / continuous kilns	Wet / dry grinding
Isostatic pressing or by impact	Chamber dryers (intermittent)	Tunnel kilns	Drilling / sawing
Continuous lamination	Tunnel dryers (continuous)	Roller hearth kilns	Rectifying / Polishing
Unconfined band pressing	Vertical 'basket' dryers	Sliding bat kilns	Carbon enrichment
Extrusion	Horizontal multi-deck roller dryers	Clamp firing	Tumbling of facing bricks
Moulding	Dehumidifying dryers	Rotary kilns (drying-firing)	Filling clay blocks with insulation materials
Slip casting	Infrared and microwave dryers	Reduction firing	

Source: JRC [5].

Current CO_2 emissions

The CO_2 intensity of ceramic-making varies depending on the product desired and technology used. Nonetheless, the vast majority of CO_2 emissions stem from the thermal processes (e.g. drying or firing processes), with specific energy requirements depending on the specific ceramic material manufactured. Figure 3 summarises the CO_2 emissions of ceramic production and their categorisation according to the GHG Protocol. Emissions belonging to Scope 3 are deemed out of scope and thus disregarded here.

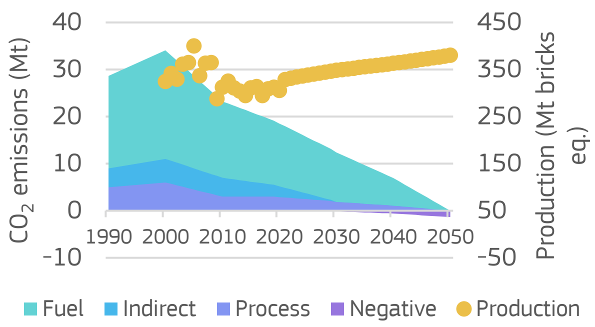
Figure 3 – Overview of CO_2 emissions of ceramic production including different scopes, sources and intensities



Source: JRC based on [1] and [5].

Since 2010, the ceramic industry has been able to decouple production from CO_2 emissions. This was achieved through process optimisation, efficient production and fuel substitution (i.e., switching from solid fuel – mainly coal – to natural gas).

Figure 4 – Evolution of CO_2 emissions (1990 to 2050) and production (2000 to 2050)



Source: JRC based on [1] and [6].

Policy targets and context

The EU has set clear ambitions for achieving climate neutrality by 2050, with a short-term target to reduce GHG emissions in 2030 by at least 55% as compared to 1990. This target, supported by the European Green Deal [7] and Fit-for-55 package [8], has led, among others, to the creation of the Industrial Technology Roadmap for Low Carbon Technologies in Energy-Intensive Industries (EIIs), impacting research and development initiatives in the ceramic sector.

More recently, the EC proposed the amendment of the 2040 climate target to reduce emissions by 90% as compared to 1990s levels. The role of industry is to reduce its emission levels by 60-90% compared to 1990. So far, the most relevant policy mechanism with direct influence over the decarbonisation of ceramic production remains the EU Emissions Trading System (EU ETS).

The 2024 list of operators of the EU ETS includes 529 ceramics production installations, which jointly reported 8.41 Mt of verified CO_2 emissions. For comparison, the 195 installations related to cement clinker production reported 81.9 Mt of verified CO_2 emissions [9]. On average, the largest ceramic plants covered by the EU ETS emit 26 times less CO_2 than clinker production plants, impacting the industry's capacity to decarbonise.

THE WAY FORWARD

Decarbonisation trajectories[1]

Two decarbonisation trajectories covering the EU ceramic industry are briefly introduced in Table 2 using 2000 as reference year: Cerame-Unie's roadmap and POTEnCIA's CETO 2024 scenario, showcasing how the deep decarbonisation of the EU's energy system can be achieved.

Cerame-Unie's roadmap combines measures to reach carbon neutrality by 2050, including the following.

- A switch to renewable energy (low carbon hydrogen, biofuels and decarbonised electricity) yields about 60% reduction of emissions from fossil fuel combustion and indirect emissions.

[1] This factsheet avoids using the term 'pathways' to prevent confusion with the sector-specific decarbonisation pathways published by the European Commission in November 2025. Those sector-specific pathways are intended as a voluntary tool to support companies set their individual decarbonisation targets in line with the European Climate Law. See EC, Making finance flows consistent with climate goals – Climate Action, 2025.

- Innovations to reduce process emissions and increase efficiency can address close to 50% of process-related emissions.
- CO_2 capture or carbon removal technologies and offsetting measures can address up to 40% of process-related emissions.

Table 2 – Overview of trajectories for EU ceramic industry

Authorship	Trajectory name	Total emission abatement		
		2030	2040	2050
Cerame-Unie	Roadmap 2050	64%	80%	100%
EC-JRC	POTEnCIA CETO	34%	82%	91%

Source: JRC based on [1] and [6] using 2000 as reference year.

Such decarbonisation trajectories entail added costs compared to conventional production: the electricity share of production costs increases for any electrified route; and the increase in capital costs and in transport and storage of CO_2 may become significant. POTEnCIA indicates a total production cost of 60 EUR/t by 2050, which is a mere 1.8% increase as compared to current levels. Cerame-Unie roadmap is poised to require investments of up to EUR 1.2 billion per year in 2050 and for a total of EUR 27 billion leading to 2050 [1].

Decarbonisation technologies

Linked to its diversity of production processes and technologies, several avenues are feasible for the decarbonisation of the ceramic industry (Table 3). Some of these decarbonisation options, e.g. incremental efficiency improvements and best available technologies (BAT), are already commercially available. Others, considered emerging [5], include the use of hydrogen; rapid and infrared dryers; microwave in the firing stage; and several CO_2 separation and concentration technologies. Table 4 summarises the estimated CO_2 abatement potential and technology readiness level (TRL) of selected technologies and measures.

CO_2 abatement costs in the ceramic industry remain confidential. Regarding circularity, research demonstrates the emission reduction potential of the reuse and recycling of specific ceramic wastes [10], while industry engagement on this topic also hints at positive economic implications. A similar observation can be made for cogeneration of heat and power (CHP), yielding to both cost and emission savings through energy efficiency.

Table 3 – Decarbonisation levers and associated technologies/measures (non-exhaustive)

Levers	Technologies / measures
Raw and alternative materials	Optimisation of input materials (e.g. local and/or decarbonised materials, incl. circularity measures) New materials to improve ceramic design
Waste Heat Recovery	Organic Rankine Cycle Heat pipe heat exchanger Heat recovery and storage Hot air recycling as combustion air
Energy Efficiency in drying	Heat pumps Microwave-assisted drying Induction heating
Energy Efficiency in firing	Tunnel kiln Hybrid kiln Electric kiln (incl. Microwave heating)
Other Energy Efficiency	Thermal efficiency & energy storage Electric efficiency Other: digitalisation (Industry 4.0)
Alternative fuels and fuel switch	Alternative fuels (e.g. biofuels; hydrogen; waste) Cogeneration of heat and power (CHP) Electrification of heat with renewable electricity
Negative emissions	Carbon capture and storage / utilisation (CCS/CCU) CCS after energy generation on site

Source: JRC based on [5] and [1111]

Table 4 – Overview of decarbonisation levers, main technologies / measures, their abatement potential and TRL

Levers	Abate. potential	Technologies / measures	TRL
Alternative materials	Up to 18%	Circular economy	High
Waste heat and other efficiency	Up to 20%	CHP Thermal storage Insulation Digitalisation	High - - -
Innovative drying and firing	Up to 63%	Heat pump④ Hybrid kiln①②③ Electrode-based heating② Induction heating② Microwave drying and heating②	- Medium - - -
Alternative fuels	Up to 82%	Biomethane③ Hydrogen① Electric kiln② & electrification④	High - -
Negative emissions	Up to 100%	Carbon capture ... for use	Low -

Source: JRC based on [11], [12]; and [13]. Notes: ① to ④ connect technologies and fuels.

STATE OF DEVELOPMENT

Industrial pledges

Commitment by the private sector is difficult to track. A few companies openly pledge to decarbonise:

[Wienerberger](), [Roca Group](), [NGK INSULATORS, LTD](), [CoorsTek Technical Ceramics](), [RHI Magnesita]() and [Sto NV SA](). Some other groups report their emissions [1414]: e.g. [Villeroy & Boch](), [Gruppo Italcer](), [Gresmalt group]().

This limited disclosure of GHG emissions may be linked to the complexity of the ceramic industry and the (relative) small size of its plants (see above). This hampers the publication of decarbonisation pledges by EU companies. The geographic distribution of emissions and energy consumption also affects decarbonisation options, both positively and negatively: it eases the local sourcing of materials and fuels, but impairs the scale of carbon capture and access to infrastructures.

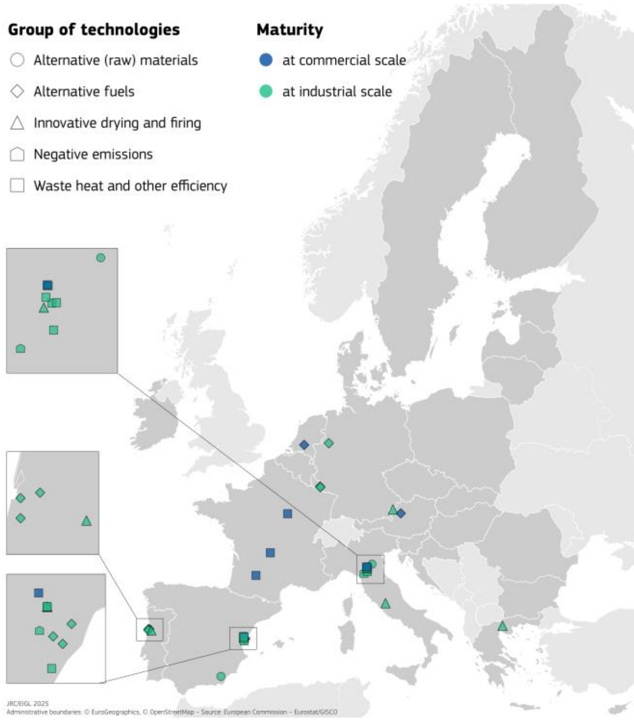
The Wienerberger group, market leader in roof tiles and bricks, representing over 10% of the verified emissions of the sector in 2024, and Villeroy and Boch, producer of table- and ornament-ware, tiles and sanitary-ware, are actively pursuing various decarbonisation options across their operations. Wienerberger is looking into raw **material efficiency, circular economy and dematerialisation.** This includes carefully selecting raw materials, increasing the use of secondary raw materials, and reducing raw material input while maintaining product quality. Both companies are investing in **fuel switching** and exploring **energy-efficient processes** (e.g. by tapping on waste heat through heat exchange from flue gases, heat pumps, and hybrid drying methods). Other pioneering projects, referring to specific products, include the examples below.

- Roca group plant commissioned the world's first electric tunnel kiln in December 2023 in Gmunden, demonstrating the feasibility of decarbonising sanitaryware production.
- Flagship project NEFI involves several decarbonisation options: holistic optimisation of the brick manufacturing process; development of new CO_2-neutral clay mixtures; optimisation of drying energy efficiency; implementation of heat pump technology and of the novel fully electric tunnel kiln.

Demonstrators

Research towards decarbonisation is progressing. Demonstration projects represent cutting-edge initiatives aimed at accelerating industrial decarbonisation through innovative technologies and sustainable practices. In this factsheet – and building on our demonstrator dataset[2] – a non-exhaustive list of 39 demonstrators associated with the ceramic industry have been identified (Figure 5). Both public and private sectors contribute to the funding of demonstrators.

Figure 5 – Non-exhaustive map of demonstration sites in the EU by type of decarbonisation lever.



Source: JRC/EIGL, 2025. Notes: Administrative boundaries: © EuroGeographics, © OpenStreetMap – Source: European Commission – Eurostat/GISCO.

Most of these demonstrators are focused on **waste heat recovery and other efficiency improvements** (13 demonstrators); **alternative fuels** (11); and **innovative drying and firing technologies** (9). They tend to be located in Spain (14) and Italy (11), with the remainder in six other EU Member States (Austria, France, Germany, Greece, Netherlands and Portugal).

Only two Innovation Fund projects directly address the ceramic industry (Mitigat and CT Quarry), with a

[2] Mapping of demonstration plants in energy intensive industries (INCITE) layer on EIGL website.

number of others with indirect relevance (focussing on the glass industry (i.e., VITRUM) or CCS).

Evaluation of progress and alignment with policy and industry targets

With the European Commission's recent proposal for a 90% emissions reduction by 2040, the sector may be prompted to accelerate its decarbonisation efforts [1515]: by 2019, the industry's CO_2 emissions had reduced by 33% compared to 1990. To achieve a 57% reduction in 2030 compared to 1990, the industry must cut emissions by an additional 6.8 Mt of CO_2, equal to 0.61 Mt yearly or 35% compared to 2019. Though this implies an accelerated decarbonisation rate compared to the 2010-2019 period (0.45 Mt yearly), the industry performed at a significantly higher rate between 2000 and 2010 (1.1 Mt yearly). The evolution of production volumes plays a role in the industry's total emissions, adding to the challenge: between 2000 and 2010, EU production decreased by 3.9%, but it may increase by 11.5% between 2019 and 2030 [6].

Of the 39 ceramic-related demonstrators mapped, a third focus on energy efficiency measures. With a relatively low decarbonisation potential, this lever does, however, benefit from favourable economics, explaining its early introduction and industry-based funding.

Innovative heating technologies are also reaching maturity, enabled by a shift towards decarbonised fuels. However, technologies and the supply chains for fuel need more investment to overcome risks such as the vulnerability to energy markets.

CCUS and other negative emissions measures are expected to offset the remaining emissions by 2050, although research on carbon capture is limited within the ceramic industry.

Decarbonising the EU's largest EIIs will require over EUR 500 billion by 2040 [16], including EUR 27 billion for the ceramic industry alone by 2050 [1].

CONCLUSIONS

The decarbonisation of the ceramic industry presents both significant challenges and opportunities. The industry produces various types of product, through numerous production processes and technologies, leading to a plethora of options towards its decarbonisation. This wealth of options leads, however, to the dilution of necessary funding in research and innovation and will involve rising investment for technological rollout.

The demonstration projects mapped in this study are a good example of how to streamline funding towards achieving climate targets. The low-hanging fruits of energy efficiency are already being implemented; public funding supports ongoing technological shifts towards innovative technologies and (connected) alternative and decarbonised energy-carriers; meanwhile CCS is being pioneered in other industries and foreseen to enter the ceramic industry from 2040.

More research and long term investment in technology and energy supply are vital to the successful decarbonisation of the ceramics industry. These require a stable, reliable legal framework and financial support. Indeed, as with all EIIs, access to competitive and decarbonised energy is, and will remain, critical for the competitiveness and decarbonisation of the EU ceramic industry.

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